Indicator: Phosphorus Discharges from Detroit Wastewater Treatment Plant

Background

Lake Erie has a long history of accelerated eutrophication. During the 1960s, Lake Erie was on the front cover of several national magazines because phosphorus-induced algal blooms and oxygen depletion of deeper waters caused fish kills. In general, phosphorus is the most scarce and readily controllable nutrient relative to plant needs. Therefore, U.S. and Canadian governments worked through the Great Lakes Water Quality Agreement to set phosphorus target loads to control water quality problems associated with phosphorus enrichment. This phosphorus control program called for controlling inputs from municipal wastewater treatment plants, controlling inputs from agricultural and urban runoff, and restricting the phosphorus content of cleaning agents and laundry detergents.

Figure 1. An aerial photograph of the Detroit Wastewater Treatment Plant – one of the largest in North America (Photo credit: Detroit Water and Sewerage Department).

The Detroit Wastewater Treatment Plant was the single largest contributor of phosphorus to Lake Erie. This regional wastewater treatment plant was constructed in 1940 and treats the waste of over three million people in 76 communities. It handles over 2,600 million liters (700 million gallons) of wastewater per day (Figure 1).

Status and Trends

In 1970, the Detroit Wastewater Treatment Plant began removing phosphorus from its effluent using pickle liquor and polymer to meet the 1 mg/L phosphorus standard for all major plants (3.8 million liters; one million gallons per day or greater). Pickle liquor (ferrous chloride) was obtained from local steel mills and pumped or fed by gravity into interceptor sewers, while polymer was injected into channels leading to the primary clarifiers. Aeration facilities for secondary treatment were constructed during 1973-1976. Through this process, ferrous chloride is converted to ferric chloride, which has been found to more effectively precipitate phosphorus. During 1979-1980, staff at the plant implemented an alternative sludge removal process, which increased sludge handling capability and indirectly increased the plant's ability to remove phosphorus.

Two statewide phosphorus control initiatives were also implemented. In 1971, Michigan enacted a phosphorus limitation of 8.7% by weight on all cleaning agents. Michigan's phosphorus detergent ban was implemented in 1977, restricting the phosphorus content of household laundry detergents to no greater than 0.5% by weight.

The combined influence of these phosphorus control efforts can be seen in Figure 2a and 2b below. The result was a greater than 90% reduction in phosphorus concentration and loading from the Detroit Wastewater Treatment Plant. Similar reductions occurred in other wastewater treatment plants; however, because of the Detroit plant's 2,600 million liter (700 million gallon) per day flow, the impact on Lake Erie was substantial. The Detroit Wastewater Treatment Plant would become the single largest cause of the reversal of cultural eutrophication of Lake Erie during the 1970s and 1980s. Lake Erie responded with dramatic improvements in water quality.

It should also be noted that as the Detroit plant expanded its municipal customers and service area, there were a number of problems in consistent and adequate operation of the plant. These problems climaxed in a 1977 Federal Consent Judgment, which outlined the specific deficiencies, areas requiring improvement, and target dates for achieving compliance. A full-scale evaluation of the plant was performed in 1979 to help ensure adequate operation of the plant. It was not until 1981, when the construction and modification of secondary settling tanks were completed, that the plant would achieve consistent operation sufficient for secondary treatment standards (Figure 2).

The story of reductions in phosphorus loadings and the subsequent reversal of cultural eutrophication of Lake Erie is one of the greatest success stories of water resource management. Indeed, the U.S.-Canada phosphorus control program is heralded as an international model. It should be noted that by the early 1990s zebra and quagga mussels invaded Lake Erie causing major changes in the food web. In recent years, blooms of blue-green algae have occurred in Lake Erie raising new concerns. The exact reasons for these blooms are uncertain. Did increased discharge of nutrients occur? Did zebra

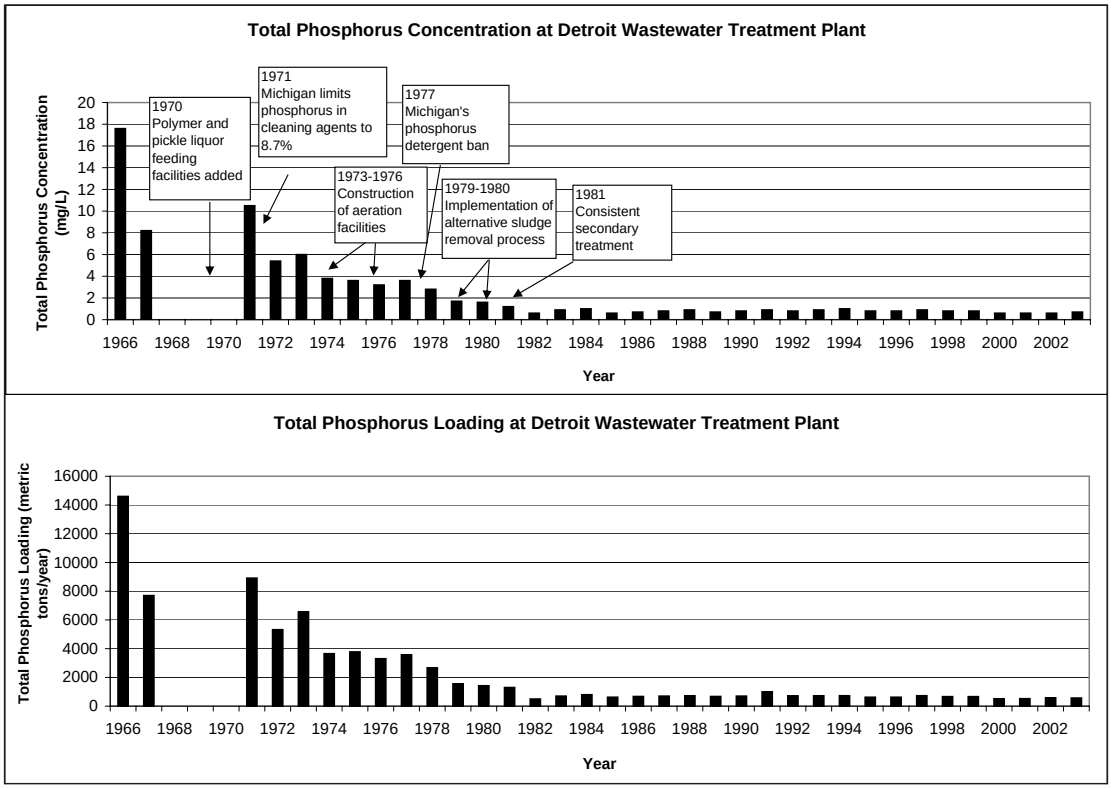

Figure 2a and 2b. Total phosphorus concentration (a) and loading (b) from Detroit Wastewater Treatment Plant, 1966-2003.

mussels change the water quality and favor productivity of blue-green algae? Will this lead to more taste and odor problems in drinking water supplies? Research needs to be focused on answering such questions.

Management Next Steps

Efforts must be sustained to control phosphorus inputs from the Detroit Wastewater Treatment Plant and others. Current management efforts are focused on addressing combined sewer overflows from Detroit and other communities. For example, Detroit is in the middle of a ten-year, $4 billion capital improvement program that began in 2000. This includes over $1 billion for controlling combined sewer overflows.

The major changes that have occurred in Lake Erie in recent years are poorly understood, but it is clear that management programs, research, and monitoring must be sustained and closely coupled in order to achieve management goals for the Detroit River and Lake Erie. The Lake Erie Committee of the Great Lakes Fishery Commission has recommended a "hold the line on phosphorus levels" until there is clear scientific evidence that suggests otherwise.

Research/Monitoring Needs

Major cuts have occurred in monitoring and research for both the Detroit River and Lake Erie. Effluent monitoring of the Detroit Wastewater Treatment Plant and other plants must be sustained for calculating reliable loading estimates, evaluating impacts of remedial efforts, understanding short- and long-term ecosystem trends, and refining modeling frameworks applied for management and decision making. Coordinated, comprehensive research will be needed to understand cause-and-effect relationships relative to the recent changes in Lake Erie and to ensure ecosystem-based management.

References

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Links for More Information

Detroit Water and Sewerage Department: http://www.dwsd.org/

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